

The Quark Search Project in Microgravity

Project Number: 96-15

Investigators: D.A. Noever/ES76

A.M. Gleeson/Chairman, Physics Dept., Univ. Texas at Austin

P. Hudspeth/Physics Instructor, Georgetown School, Austin, Texas

Research Summary

This research has assessed the microgravity related potential of fractional charge (free quarks) detection in stable matter. The quark is an elementary nuclear particle which is fractionally charged. The study has evaluated the feasibility of looking for the first evidence of quarks existing in stable matter.

Because previous evidence for quarks has been found only in high-energy particle colliders, the research outcome, as evaluated here in low-energy (stable) matter, holds considerable promise for advancing the frontiers of elementary particle physics. Because its implementation relies on levitating an electrically grounded steel sphere, the experiment can be conducted meaningfully only in microgravity. If the sphere is grounded but held in a constant electrical field, only the appearance of a fractional charge (free quark) can perturb its trajectory. Electrical grounding neutralizes the background of unit charges which build up, and therefore the sphere's movement between two oppositely charged plates reveals only the discrepancies (fractional quark charges) between the expected and observed values of the fundamental charge unit. With a grounded sphere, the only method for free suspension is a microgravity environment for quark detection.

The measurement of accelerations in the direction of the electric field lines determines the amount of charge on such a suspended sphere. Gravity can interfere and compete with the electrostatically induced movement of large, electrically-grounded spheres, since the kind of fractional charges

speculated to exist in stable matter are beyond the limits of Earthbound detection.

The research plan has undertaken feasibility studies leading to several KC-135 flights (April 1997) and preliminary hardware specification for a Shuttle or satellite experiment (July 1997, first feasibility test for satellite package).

Specifically the following benefits can be expected from experimentation on free quarks in reduced gravity:

- Split away complicated electrical field effects and asymmetries from strictly gravitational effects on particle or sphere trajectories.
- Actively manipulate particle trajectories by radium source capture and ion bombardment, as has been tried previously by several authors, but remained inconclusive because of gravity complications (Stokes sedimentation and convection). Under reduced gravity, such side effects will be minimized.

The research has developed and studied technological requirements for microgravity detection of quarks.

Related Publications

Noever, D.A.; and Rosenberger, F.: "A Proposed Nonintrusive Method for Finding Coefficients of Slip and Molecular Reflectivity in Microgravity," NASA CR-183558, 1988.

Noever, D.A.: "Polarized Nuclei in a Simple Mirror Fusion Reaction," *Fusion Technology*, 27; 86-102, 1995.

The instrument design for the Quark Search Project will be evaluated for scale-up to a Shuttle glovebox or middeck locker experiment, a free-flying satellite, or tethered platform. The research thrust is to use a modified apparatus which suspends drops or metallic spheres between two charged electrical plates in microgravity (fig. 31). This so-called Millikan apparatus is a modification of the classical physics laboratory experiment, for which Millikan won the Nobel Prize.

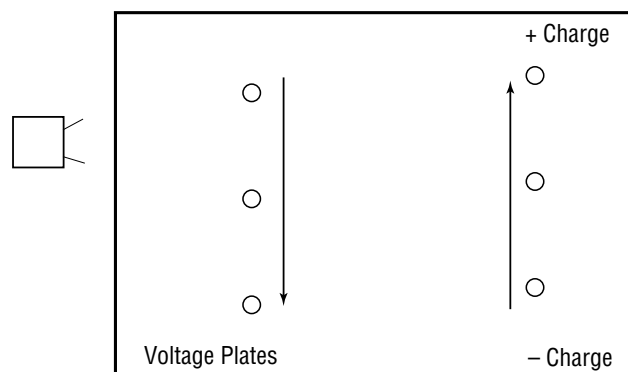


FIGURE 31.—A conceptual drawing of fractional charge measurement apparatus for microgravity free quarks.

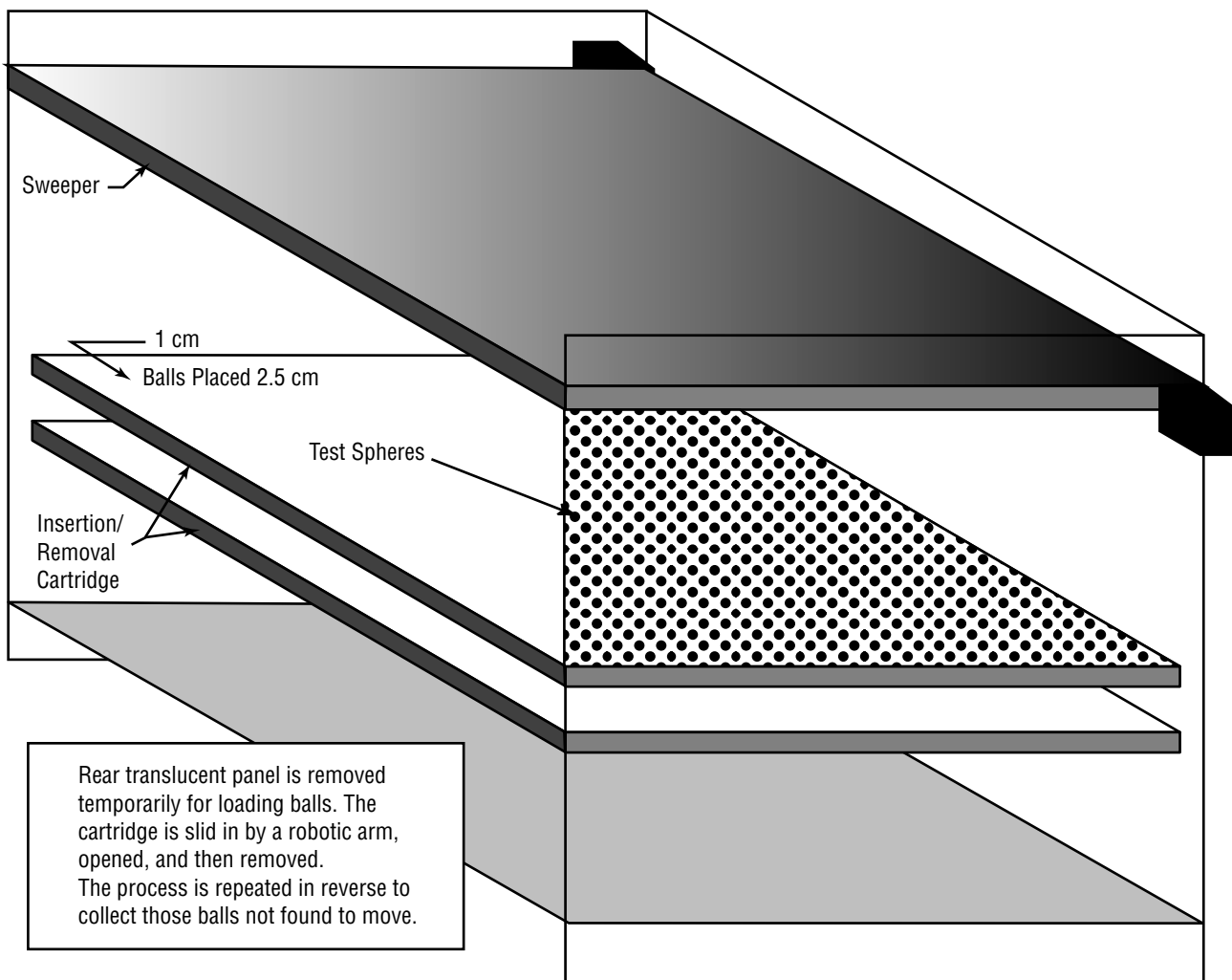


FIGURE 32.—Cartridge-based delivery/removal apparatus, scale 1:3.